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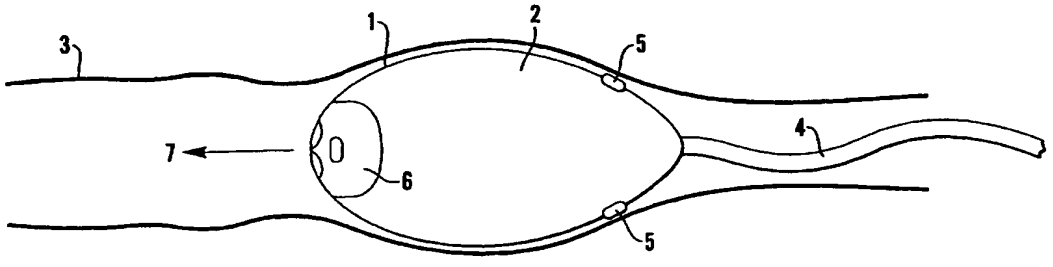
(54) Title: IMPROVED PASSAGE-TRAVELLING DEVICE



(57) Abstract: A self-propelling device (1) is adapted to travel through a passage (3) having walls containing contractile tissue, the device (1) comprising a body (2) and at least one contractile tissue-stimulating means for stimulating the walls to urge the device in a forward direction (7). The stimulating means may be electrodes (5, 8), and the passage can be the gut of an animal or human. The device is particularly useful as an enteroscope.

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IMPROVED PASSAGE -TRAVELLING DEVICE

FIELD OF THE INVENTION

The present invention relates to a device, capable of propelling itself along a passage having walls containing contractile tissue.

BACKGROUND ART

Electrical stimulation has been extensively used as a method of inducing contraction of strips of muscular tissue. Further, direct smooth muscle stimulation has also been used to improve emptying of ileal and colonic pouches in animals and humans.

In addition, UK patent application 9808426.2 describes a device, such as an endoscope, having means for propelling itself along a tortuous passage by way of suction means. The means comprises a first suction means mounted on the endoscope and a second suction means mounted thereon for movement with respect to the first suction means longitudinally of the endoscope, the first and second suction means each being arranged, when actuated, to grip the tissue of a body passage in which the endoscope is disposed.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention, a device is provided that is adapted to travel through a passage having walls containing contractile tissue the device comprising a body and at least one contractile tissue stimulating means for urging the device in a forward or backward direction.

According to a second aspect, the present invention provides a method of propelling a device along a passage having walls containing contractile tissue,

comprising stimulating contractile tissue in the walls so as to contract the wall in contact with the device, and so urge the device in a forward or backward direction.

Preferred features of the invention will be evident from the accompanying dependent claims.

The present invention will now be further described in the following non-limiting examples as illustrated by the accompanying drawings in which:-

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 represents a device, according to one embodiment of the invention, in which the stimulating means comprises a pair of electrodes located at the rear of the body of the device;

Figure 2 illustrates a second embodiment of the present invention, in which a pair of electrodes is located both at the rear and front of the body of the device; and

Figure 3 illustrates a third embodiment of the present invention, which is similar to that shown in Figure 2, but where no umbilicus is attached to the device.

BEST MODE

Whilst the passage through which the device (1) travels may be any passage containing contractile tissue, a particularly useful application of the device is for investigation of the gut of animals or humans. Thus, in Figure 1 a self-propelling device (1) is shown comprising a body (2) adapted to travelling within a gut (3) of an animal or a human in a forward direction (7). On the body (2) are located stimulating means which, in Figure 1, comprises a pair of electrodes (5). These are located toward the rear of the device on a tapered

portion. In operation, the electrodes (5) electrically stimulate the smooth muscle of the gut (3) wall which contracts and so squeezes the body (2) along the passage, in a similar way that natural peristalsis propels a bolus of food.

Thus, when a voltage is applied to the electrodes (5), a current flows through the wall of the gut (3) causing the smooth muscle tissue of the wall to contract and so squeeze the device (1) forwards. As the device is squeezed forwards new wall tissue is brought into contact with the electrodes (5), and so this new tissue is, in turn, electrically stimulated and so contracts to squeeze the body (2) of the device (1). The device therefore advances smoothly along the passage so long, as a stimulating voltage is applied. In this way, generalised autonomic peristalsis is not stimulated, but instead the local muscles and nerves of the gut are directly stimulated, to produce a local contraction, which is propagated by the electrodes as the device travels along the passage.

Under certain circumstances it may be preferable to view the tissues when they are inflated. Inflating the tissues may prevent a reliable electrical contact from being made but, were this to happen, the problem can be overcome by stimulating the tissues prior to inflation so as to advance the device. Once the device (1) has advanced sufficiently far along the passage, for example the colon or small bowel, the current may be switched off and the bowel inflated so that it can be viewed with a camera, the device (1) being pulled progressively back by an umbilicus (4).

Preferably, the body (2) has a substantially tapered rear portion, so that the body (2) is, for example, lozenge-shaped, hence allowing the forward movement (7) to be smooth. However, any shape of body (2) will suffice as long as the device will be urged forwards when squeezed by the gut as it contracts. Thus, the body (2) may have a shape similar to that of a rugby ball or to a cylinder with hemispherical ends. Indeed, the body (2) may also be in the form of an inflatable balloon with external electrodes (5,8) that can be inserted in an uninflated state through a small orifice into a larger part of the gut or passage, in which it is subsequently inflated ready for travel.

The umbilicus (4) may be arranged so that it can transmit information from the device (1) to a remote station, for example a screen viewed by a doctor. The nose (6) may comprise any one or more of a camera means, a light means and means for supplying air or water to inflate the passage. The device may also be used to carry objects such as feeding tubes, guide wires, physiological sensors or conventional endoscopes within the gut.

The body (2) may also comprise a rear chamber in which the umbilicus (4) can be stored and gradually paid out as the device (1) travels forward.

Generally, the electrodes (5) receive a voltage of between 2 and 10V, more preferably 3 and 5V, at a frequency of 3Hz to 20kHz, more preferably 10Hz to 30Hz.

As previously mentioned, the rear portion of the body (2) is typically tapered in shape with respect to the longitudinal axis of the body (2), and preferably at a taper angle of between 5° and 80° half angle, and preferably between 10° and 45° half angle, since such angles give a good compromise between ease of squeeze and ease of progress.

The body (2) is preferably constructed to have a length appropriate to the passageway in which it will travel. For example, in the human small bowel a length of between 1 and 5 cm, preferably between 2 and 4 cm, and a width of between 0.5 and 3 cm, preferably between 1 and 2 cm, would be appropriate.

A second embodiment is shown in Figure 2, in which a second pair of electrodes (8) are located on the front , or nose, end of the device's body (2). This second pair of electrodes (8) can be used to stimulate the gut (3), instead of the first pair of electrodes (5), to allow the device (1) to travel in a backward direction. Under certain circumstances, it may be desirable to lock the device

(1) in one place, in which case, all electrodes (5,8) can be activated simultaneously, so that the device (1) is enclosed by contracted tissues.

In Figure 3, a third embodiment is illustrated in which an umbilicus is absent, but instead a transmitter/receiver unit (9) is located in the body (2) allowing an operator at a remote station to communicate, and thus operate, the device (1). The absence of umbilicus necessitates the presence in the body (2) of an independent power source (10), for example a known type of battery. Electric current can thus be supplied to either pair of electrodes (5,8) according to the desired direction of travel.

A particularly attractive feature of the device described above is that it is very useful in enteroscopy, that is, the inspection of the small bowel. Enteroscopy has until now remained difficult, since the small bowel in the gastrointestinal tract is mostly inaccessible to standard endoscopy. This is because either the endoscopist must push an endoscope from the caecum or the duodenum, or he must slowly allow natural peristalsis to push an extremely flexible endoscope down through the digestive tract, so that he can observe the walls of the small bowel as the endoscope is pulled backwards.

Neither of these approaches is satisfactory, since the technical difficulties of such pushing only allow the ends of the small bowel to be investigated, whilst the long time (several hours) allowed to pass a standard endoscope is most unpleasant and impractical.

Thus, the device as described above, which is capable of carrying a small camera and a light source both rapidly and smoothly through the small bowel is of considerable benefit.

CLAIMS

1. A device (1) adapted to travel through a passage (3) having walls containing contractile tissue, the device (1) comprising a body (2) and at least one contractile tissue-stimulating means for urging the device (1) in a forward or backward direction.

2. A device as claimed in claim 1, wherein the contractile tissue is either smooth or striated muscle.

3. A device as claimed in either claim 1 or claim 2 wherein the device comprises at least a pair of electrodes (5) and means (4) for supplying an electric current to said electrodes.

4. A device as claimed in claim 3, wherein at least a pair of electrodes (5) are located on at least one end of the body (2) and in an orientation relative to the body (2) that is opposite to that of the direction of travel required.

5. A device as claimed in any preceding claim, wherein the portion to the rear, in relation to the direction of travel, of the body (2) is substantially tapered with respect to its longitudinal axis.

6. A device as claimed in claim 5, wherein the angle of taper is between 5° and 80° half angle, preferably between 10° and 45° half angle.

7. A device as claimed in any preceding claim, wherein the body (2) has a length of between 1 and 5 cm, preferably between 2 and 4 cm.

8. A device as claimed in any preceding claim, wherein the width of the body (2) is between 0.5 and 3 cm, preferably between 1 and 2 cm.

9. A device as claimed in any of claims 1-4, wherein the body is lozenge-shaped, or shaped substantially as a cylinder with hemispherical ends, or is an inflatable balloon capable of assuming a required shape upon inflation.

10. A device as claimed in any preceding claim, further comprising an umbilicus (4) attached to one end of the body (2), said umbilicus (4) being capable of transmitting information to a remote station.

11. A device as claimed in any of claims 1-9, wherein the device (1) is without attachment to any means passing out of the passage (3).

12. A device as claimed in any preceding claim, wherein the body (2) contains any one or more of: a camera means, a light means, means for supplying air or water to inflate the passage, means for storing energy to be supplied to the electrodes as electrical current, and means for receiving or transmitting data to a remote station.

13 A device as claimed in any preceding claim, wherein the passage is the gut of an animal or human.

14. A device as claimed in any preceding claim, wherein the device is an enteroscope.

15. A device as claimed in any preceding claim adapted to transport objects including: feeding tubes, guide wires, physiological sensors and/or endoscopes.

16. A device (1) adapted to travel through a passage (3) having walls of contractile tissue, substantially as hereinbefore described with reference to, and/or as illustrated by, the accompanying drawings.

17. A method of propelling a device (1) along a passage having walls containing contractile tissue, comprising stimulating contractile tissue in the walls, so as to contract the wall (3) in contact with the device, and so urge the device in a forward or backward direction (7).

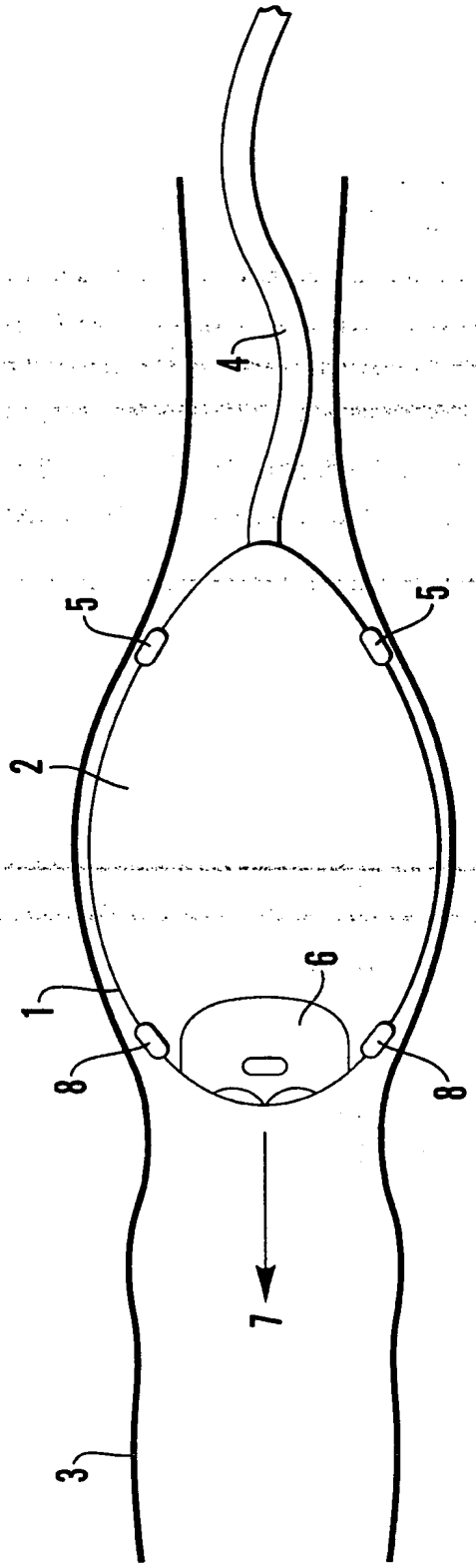

Fig.2

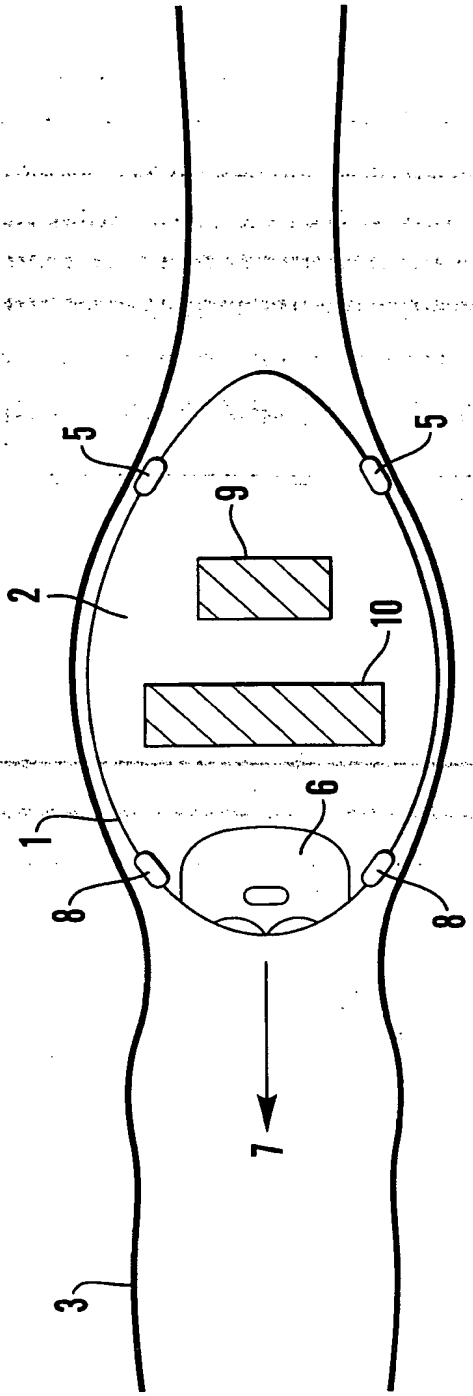

Fig.3

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61B1/01 A61B1/05 A61M25/01 A61N1/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61B A61M A61N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 237 648 A (ZACOUTO) 14 February 1975 (1975-02-14)	1-3,5,9, 11-13,16
A	the whole document	4,6-8,17

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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Date of the actual completion of the international search	Date of mailing of the international search report
2 November 2000	09/11/2000

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

...formation on patent family members

Inter nal Application No
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 2237648 A	14-02-1975	NONE	

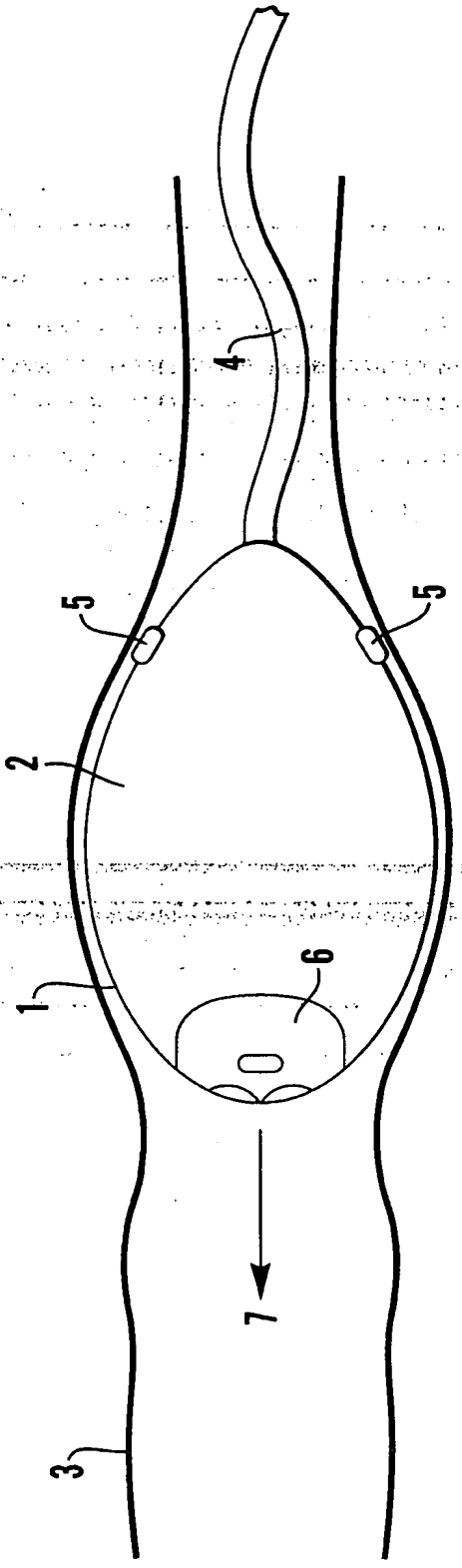

Fig.1